XVIII. NWA 480/1460

Basaltic Shergottite
28 + 70 grams

Figure XVIII-1*: Photograph of NWA 480 kindly provided by Bruno Fectay and Carine Bidaut.*

Introduction

NWA 480 (28 g) was found in November 2000 in Morocco (Barrat *et al.* 2001, 2002; Grossman and Zipfel 2001). It was almost completely covered with fusion crust (figure XVIII-1) and appeared to be rather fresh with only a few spots of weathering products on the surface. NWA 480, was sold to the National Centre for Space Studies (CNES), where it is "*being put to use to prepare for analysis of samples returned by planned missions to Mars" (according to Philippe Gillet*) and is being studied by *Consortium Théodore Monod.*

In December 2001, NWA 1460 (70.2 g) was acquired in Agadir, Morocco (Irving and Kuehner 2003). This sample is also covered with a fusion crust and appears to be paired with NWA 480 *(preliminary assessment).*

Petrography

This meteorite has a coarse-grained basaltic texture consisting predominately of subhedral to euhedral pyroxene (up to 5 mm) and interstitial, lath-shaped maskelynite (Grossman and Zipfel 2001).

NWA 480 contains "melt pockets" as well as maskelynite and stishovite (Barrat *et al*. 2002), indicating that it has been shocked.

Mineralogical Mode

	Barrat *et al.* (2002)
Pyroxene	72 vol. %
Plagioclase	25
Phosphate	1
Opaques	1

Photos of this sample can also be seen at http://www.jpl.nasa.gov/snc/nwa480.html

Mineral Chemistry

Pyroxenes: Pyroxenes in NWA 480 (figure XVIII-2) are complexly zoned with Mg-rich cores ($En_{77}Fs_{20}Wo_3$-$En_{65}Fs_{29}Wo_6$), surrounded by Mg-rich augite ($En_{41}Fs_{29}Wo_{30}$) and finally zoned to Fe-rich pigeonite ($En_5Fs_{84}Wo_{11}$). There is no exsolution in the pyroxene except for the most Fe-rich.

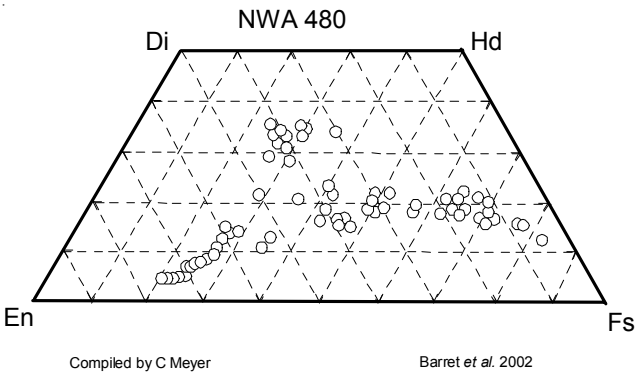

***Figure XVIII-2**: Pyroxene quadrilateral for NWA 480 (data replotted from Barrat et al. 2002).*

Maskelynite: All of the plagioclase has been shocked to form maskelynite ($An_{46-50}Ab_{52-48}Or_{2)}$.

Phosphates: Both merrillite and chlor-apatite are present in NWA 480. Fayalite-silica symplectite intergrowth is illustrated surrounding merrillite in figure 7 of Barrat *et al.* (2002).

Oxides: Analyses of ilmenite and chromite are given in Barrat *et al.* (2002).

Silica: Silica grains found included in maskelynite have been found to be a mixture silica glass and stishovite by Raman spectroscopy (Barrat *et al.* 2002).

Baddeleyite: ZrO_2 has been reported in NWA 1460 by Irving and Kuehner (2003).

Note: Crozaz et al. (2001) have determined the REE pattern of pyroxenes, apatite and merrillite in NWA 480. The low-Ca pyroxenes are found to have 'elevated La' – presumably due to terrestrial contamination, despite the fresh appearance of this meteorite.

Whole-rock Composition

The chemical composition of NWA 480 is reported by Barrat *et al*. (2001, 2002) (Table XVIII-1). The REE pattern (figure XVIII-3) was found to be "similar" to ALH77005 – which is a lherzolitic shergottite. It is thought that this basalt may link the origins of the two basic types of shergottite (Barrat *et al.*, Crozaz *et al*. 2001).

NWA 480 has normal Th/U, Ba/La and Sr/Nd ratios similar to Antarctic Martian meteorites, indicating that

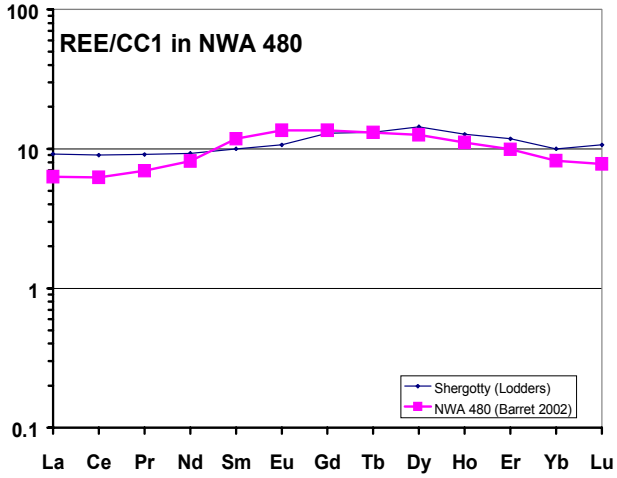

***Figure XVIII-3**: Normalized rare earth element diagram for NWA 480 and Shergotty (data from Barrat et al. 2002 and Lodders 1998).*

it is a fresh meteorite, free of the effects of terrestrial weathering (Barrat *et al*. 2002).

Cosmogenic Isotopes and Exposure Ages

Marty *et al.* (2001) report an "average exposure age" of 2.4 ± 0.2 Ma.

Other Isotopes

Barrat *et al*. (2001, 2002) determined the isotopic composition of oxygen as $\delta^{17}O = 2.91‰$, $\delta^{18}O = 4.78‰$, with $\Delta^{17}O = +0.42$ ‰.

***Figure XVIII-4:** Copyrighted photograph of NWA 1460 taken by Nelson Oakes showing nearly complete fusion crust.*

Table XVIII: Composition of NWA 480.

reference	Barrat 2002	
weight	182 mg.	
SiO2 %		
TiO2	1.16	(a)
Al2O3	6.46	(a)
FeO	19.44	(a)
MnO	0.51	(a)
CaO	9.32	(a)
MgO	10.06	(a)
Na2O	1.26	(a)
K2O	0.1	(a)
P2O5		
sum		
Li ppm	2.93	(b)
Be	0.21	(b)
Sc	28	(b)
V	202	(b)
Cr	2121	(a)
Co	37.6	(b)
Ni	63	(b)
Cu	17.6	(b)
Zn	64	(b)
Ga	16.27	(b)
Ge		
Rb	2.67	(b)
Sr	49.3	(b)
Y	16.46	(b)
Zr	58.74	(b)
Nb	1.99	(b)
Cs ppm	0.19	(b)
Ba	28.4	(b)
La	1.48	(b)
Ce	3.77	(b)
Pr	0.619	(b)
Nd	3.7	(b)
Sm	1.73	(b)
Eu	0.76	(b)
Gd	2.67	(b)
Tb	0.477	(b)
Dy	3.05	(b)
Ho	0.62	(b)
Er	1.57	(b)
Tm		
Yb	1.33	(b)
Lu	0.19	(b)
Hf	1.64	(b)
Ta	0.1	(b)
W ppb	340	(b)
Th ppm	0.22	(b)
U ppm	0.064	(b)

technique (a) ICP-AES, (b) ICP-MS

Processing

Photos of NWA 480 show that it was first sliced by a saw cut across one end (main mass 25 g).

Figure XVIII-5: *Photograph of sawn surface of NWA 1460 showing basaltic texture similar to that of NWA 480. Photo by Nelson Oakes.*